



The Concord
Consortium

Class-tested and Research-based Digital Inquiry Models for Science

Dan Damelin, The Concord Consortium
dan@concord.org



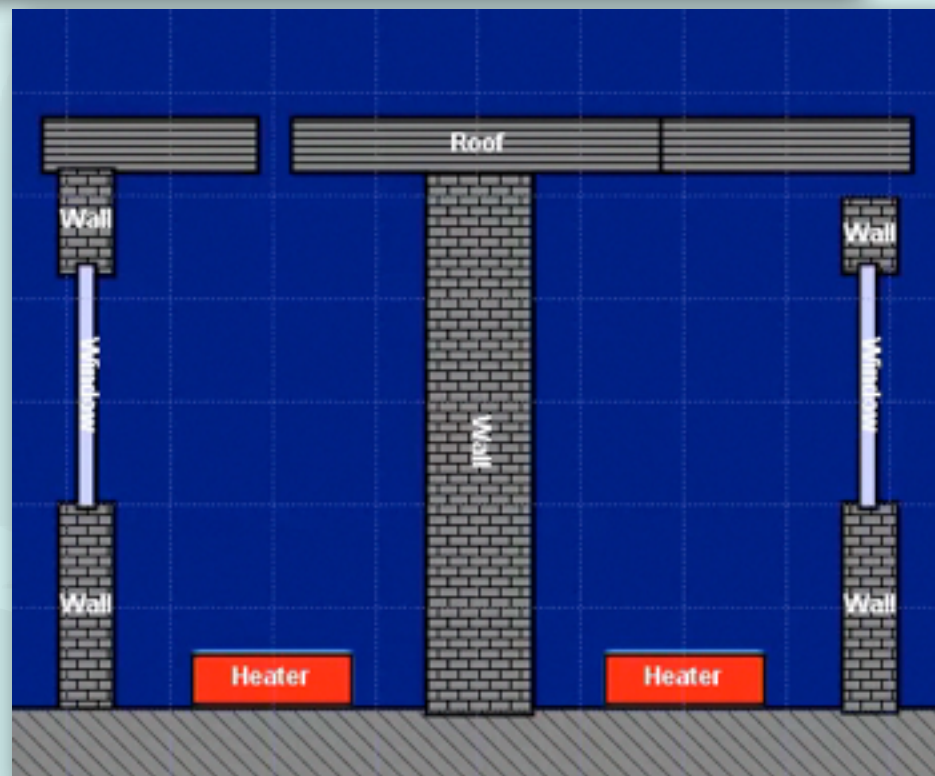
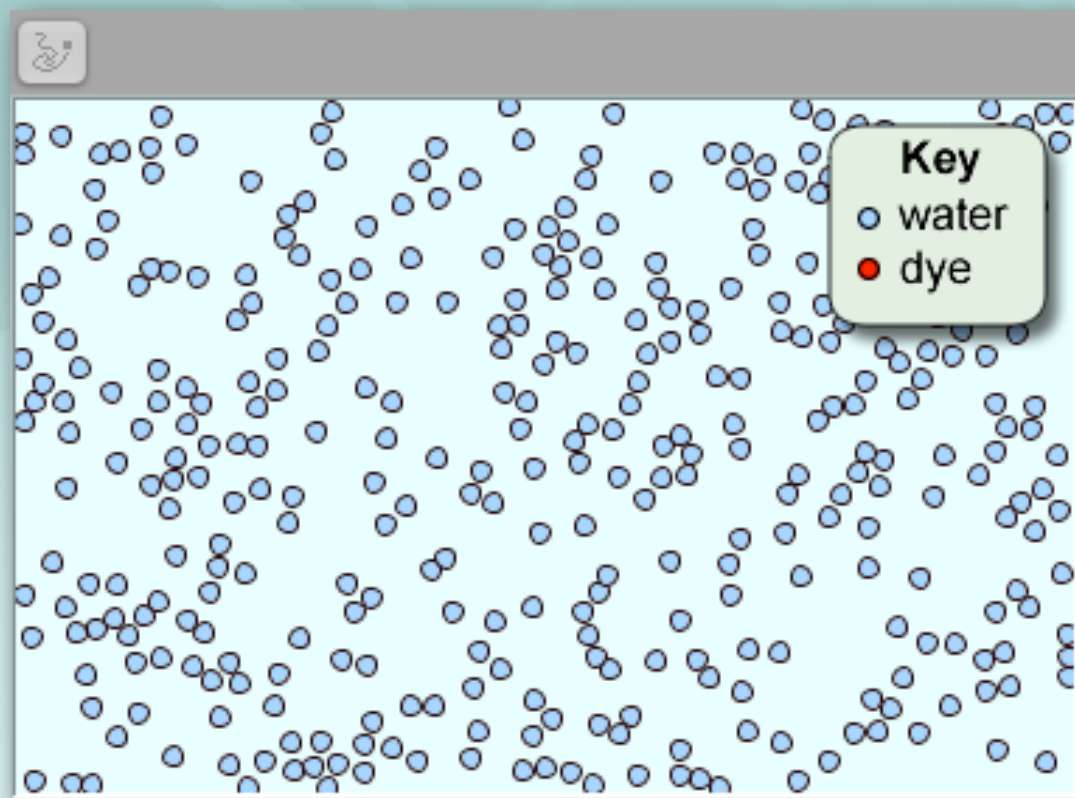
The development of this program was funded by the National Science Foundation. Any opinions, findings, and conclusions or recommendations expressed in the materials associated with this program are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

Realizing the Promise of Education Technology

- A nonprofit educational research and development organization based in Concord, Massachusetts.
- We create interactive materials that leverage the power of information technologies.
- Software is open-source and materials are Creative Commons.
- Our goal is to improve learning opportunities for ALL students.



Modes of Inquiry - Models



Use the animation controls below to go on a guided tour of an aquapore.

At each stop on the tour you can explore the model by dragging the mouse to rotate the model and shift-dragging to zoom the model.

Check out the questions below to find out what kind of snapshots you should take along the way.

*Note: With large biological molecules the hydrogen atoms are commonly not shown.

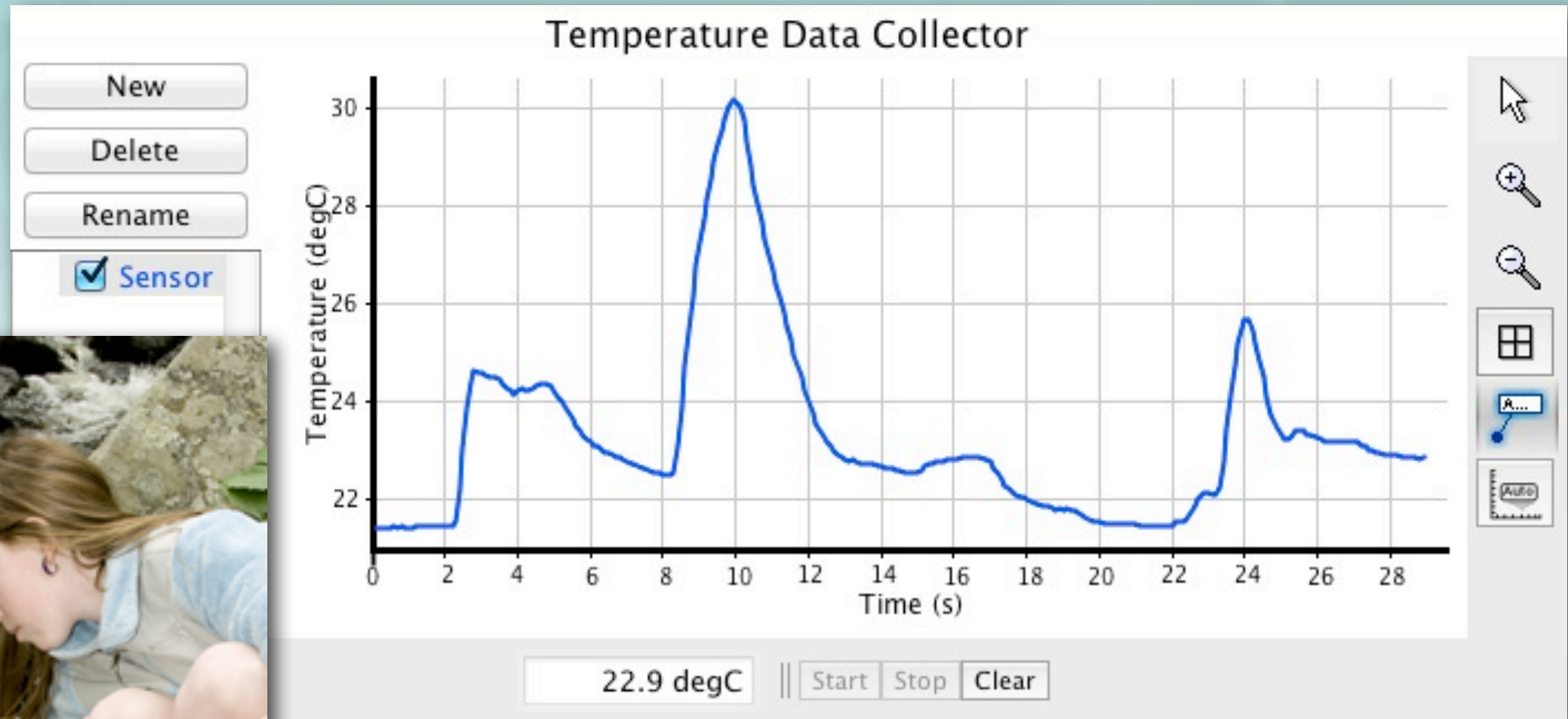
Jmol

*Note: With large biological molecules the hydrogen atoms are commonly not shown.

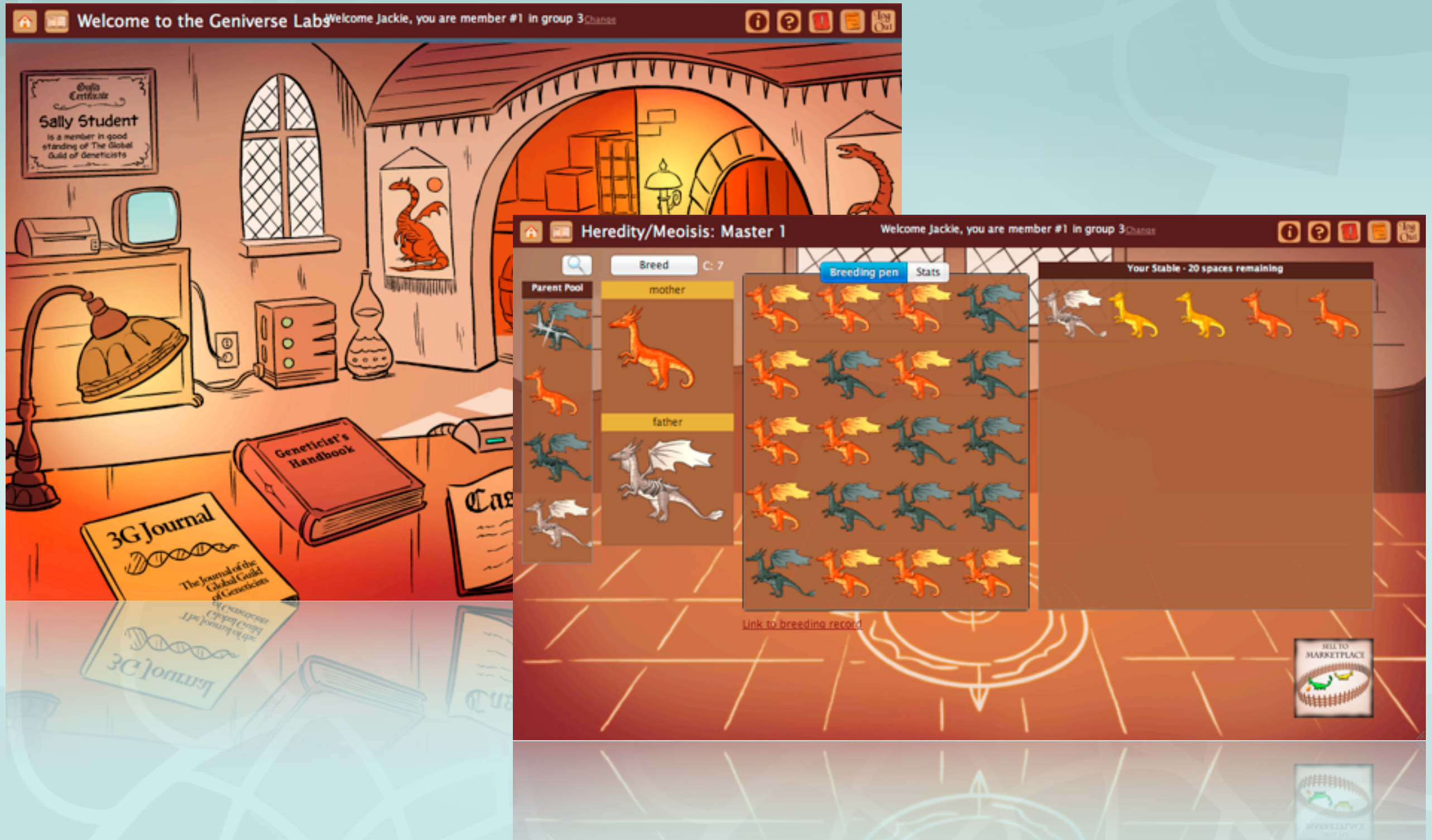
Jmol

you should take along the way.
to find out what kind of snapshots

Modes of Inquiry - Probes



Modes of Inquiry - Games



The screenshot displays the Geniverse Lab game interface, which is a genetics simulation. The main window is titled "Welcome to the Geniverse Lab" and shows a virtual laboratory environment. A smaller window titled "Heredity/Meiosis: Master 1" is overlaid on the main window, showing a breeding simulation. The breeding simulation includes a "Parent Pool" with various dragon-like creatures, a "Breeding pen" with a grid of offspring, and a "Stats" panel. The "Parent Pool" shows a "mother" (orange dragon) and a "father" (white dragon). The "Breeding pen" shows a grid of offspring, with a "Link to breeding record" button below it. The "Stats" panel shows a "Your Stable - 20 spaces remaining" section. The interface also includes a "3G Journal" and a "Geneticist's Handbook" on the desk.

Models

Ideal Learning Environment

- Dynamic nature of many systems not easily conveyed with text and static images.
- Animations help, but don't allow students to construct knowledge. Student is passive learner.
- **Models which are computed in real-time allow users to probe the simulation by changing parameters. Student becomes an active learner.**

The Modeling Environment:

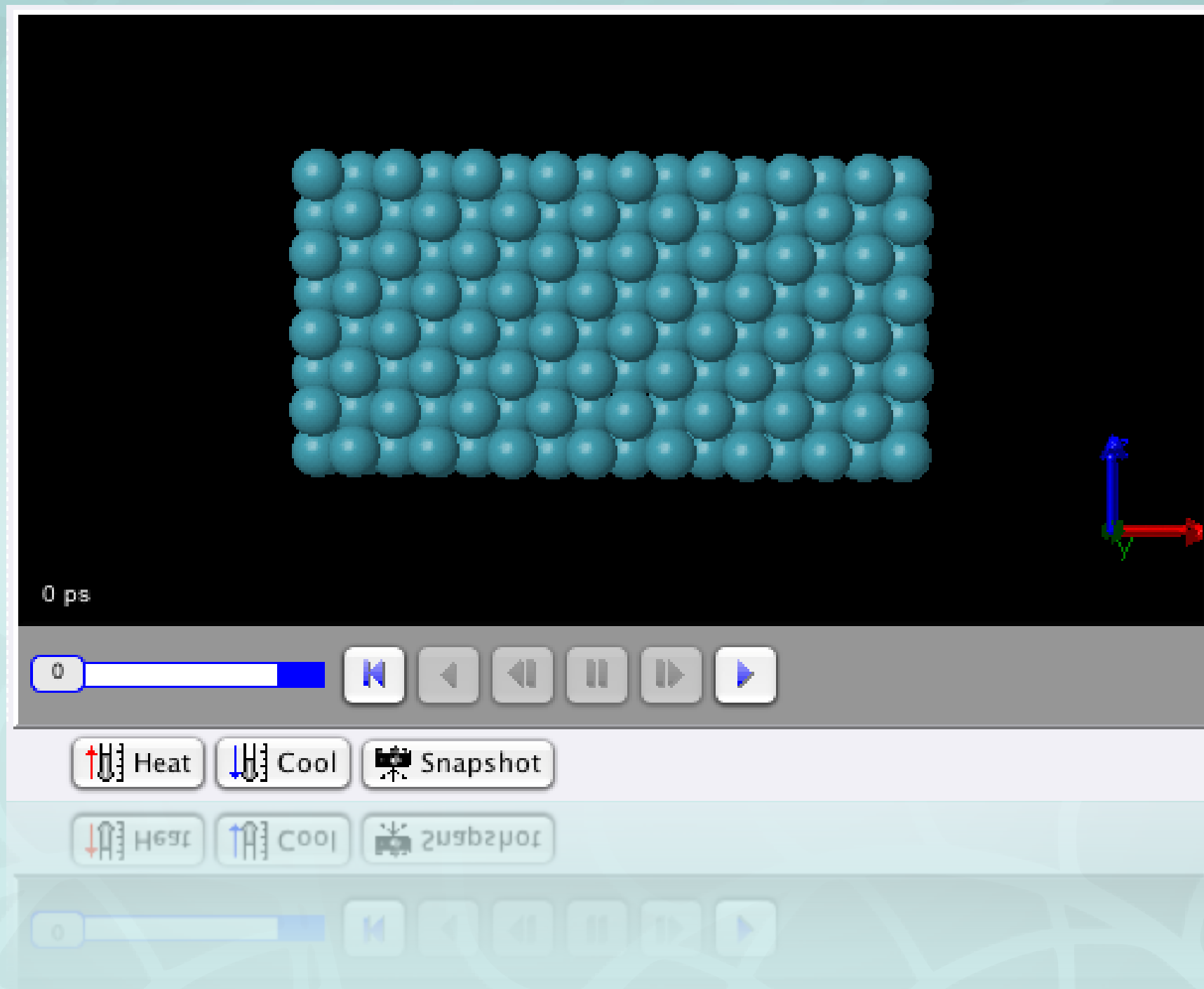
Molecular Workbench – a molecular dynamics tool.

The Molecular Workbench – a molecular dynamics tool.

- Open-source cross-platform molecular dynamics engine.
- Calculates complex real-time interactions between atoms and molecules.
- User friendly interface for creating custom model-based activities.

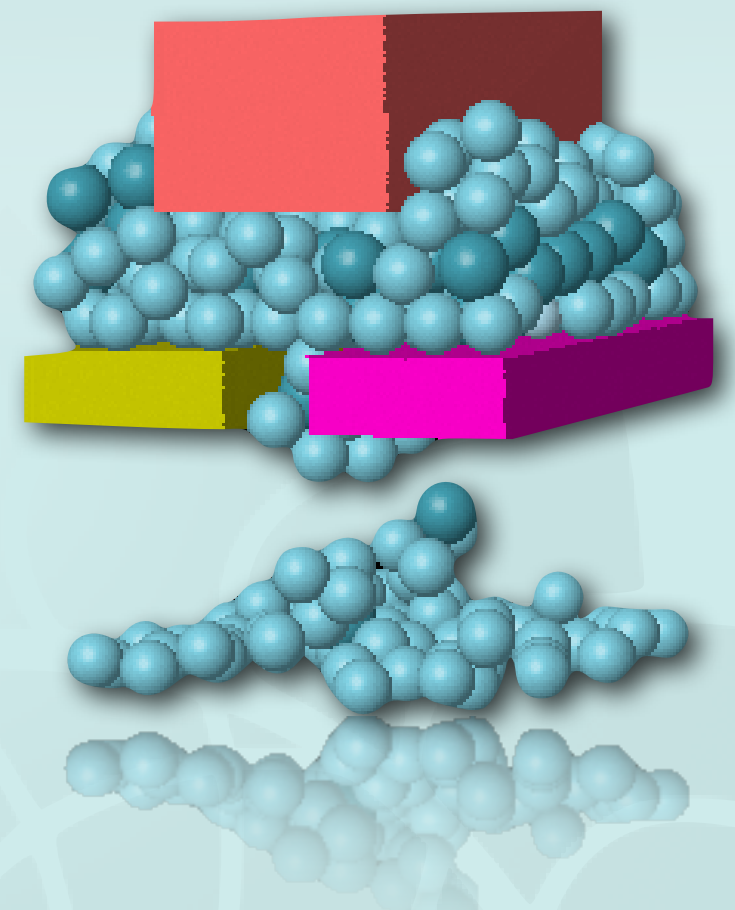


Dynamic Phase Change Model

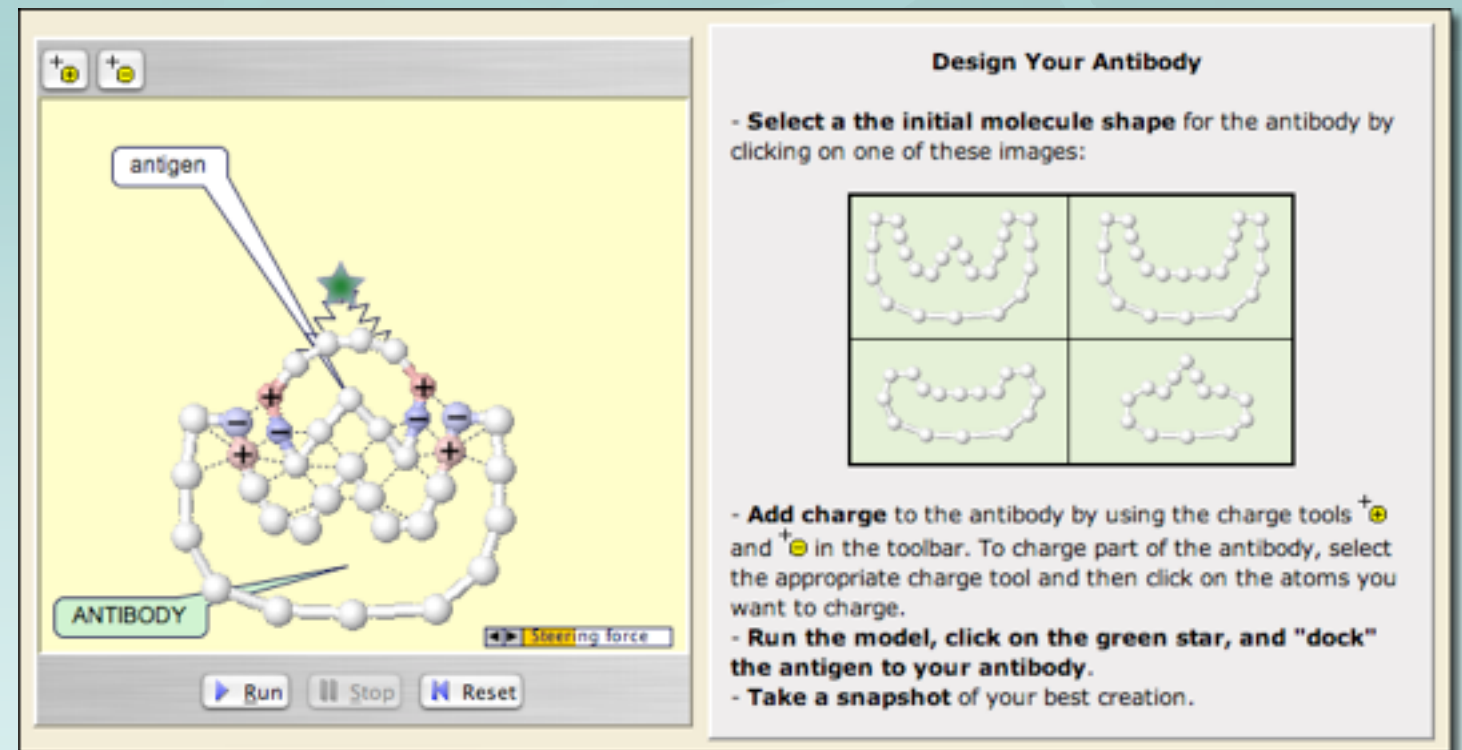


Other Reasons to Like Models

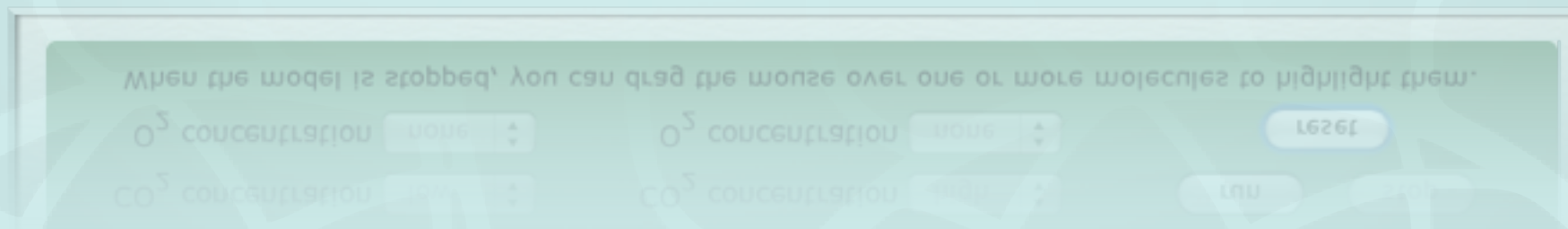
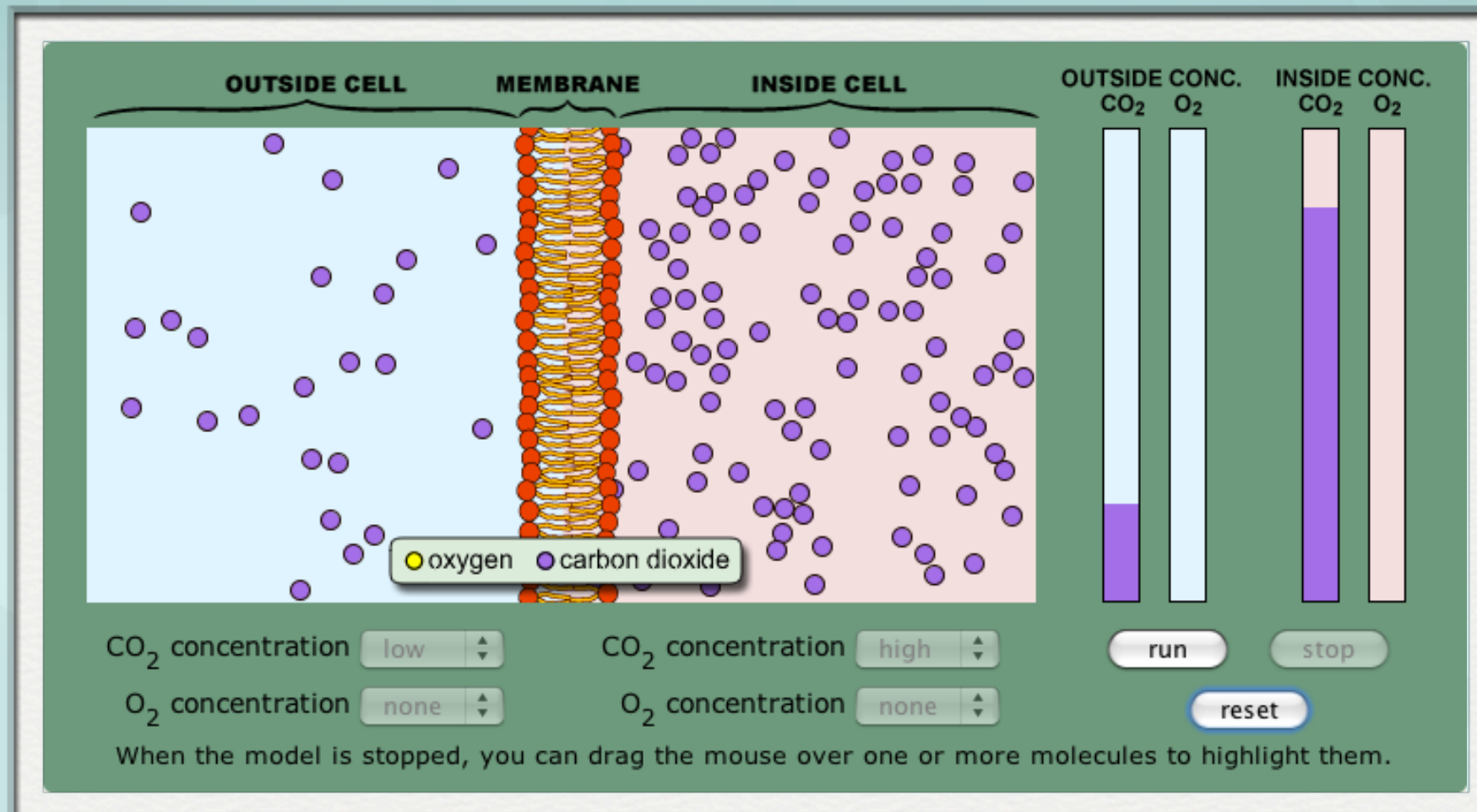
- Help to provide a concrete scaffold for new abstract concepts.
- Can be used in guided inquiry mode.
- Promotes reasoning and supporting ideas with evidence.



- 2D and 3D Molecular Dynamics Models
- 3D Exploration of Static Molecular Representation
- Flash based models
- Abstract dynamic models of DNA, RNA and proteins
- Quantum physics - tunneling, bonding, time dependent Schrodinger representations
- Macro-level models of climate and heat flow
- Models made with NetLogo and Phet embedded in contextualized environment

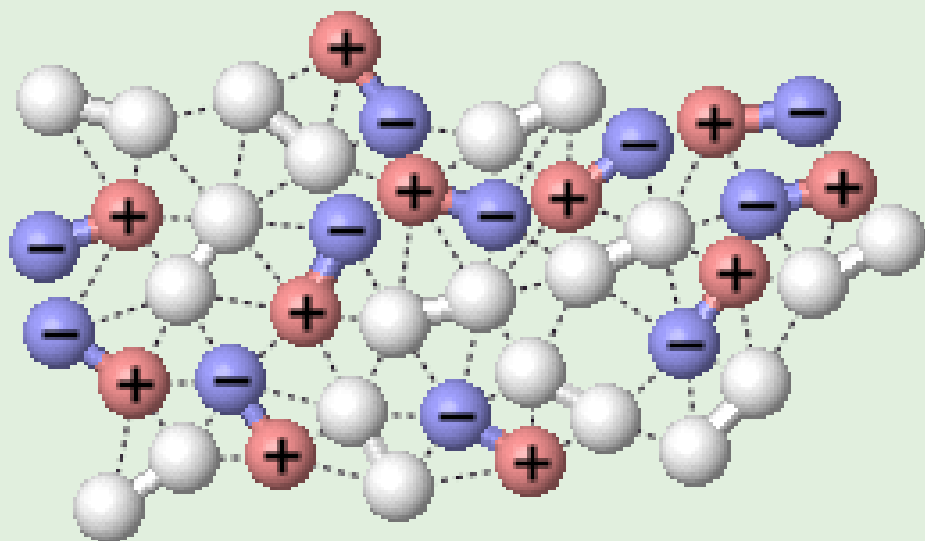


Biology - Equilibrium



Chem/Bio - Intermolecular Attractions

Oil and Water Shaken Up and Mixed



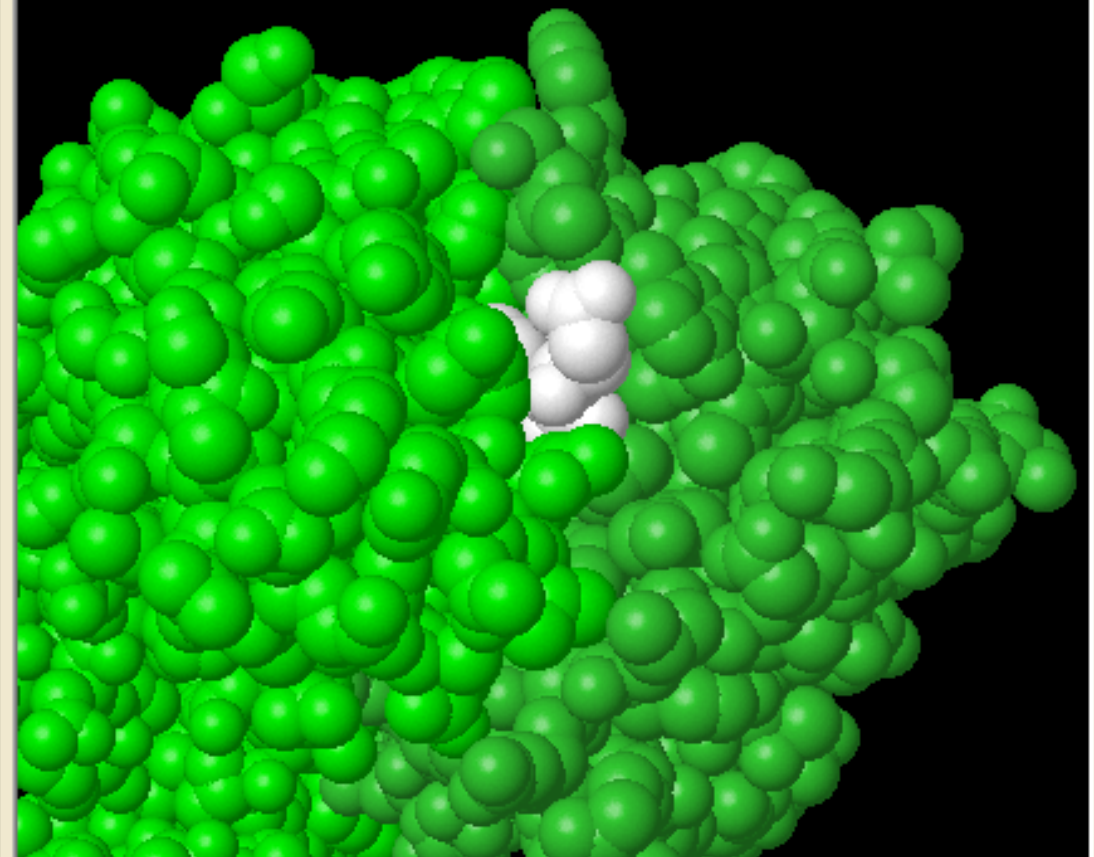
press run to see the mixture "settle"

▶ Run

⏏ Stop

⏮ Reset

Antibody/Antigen



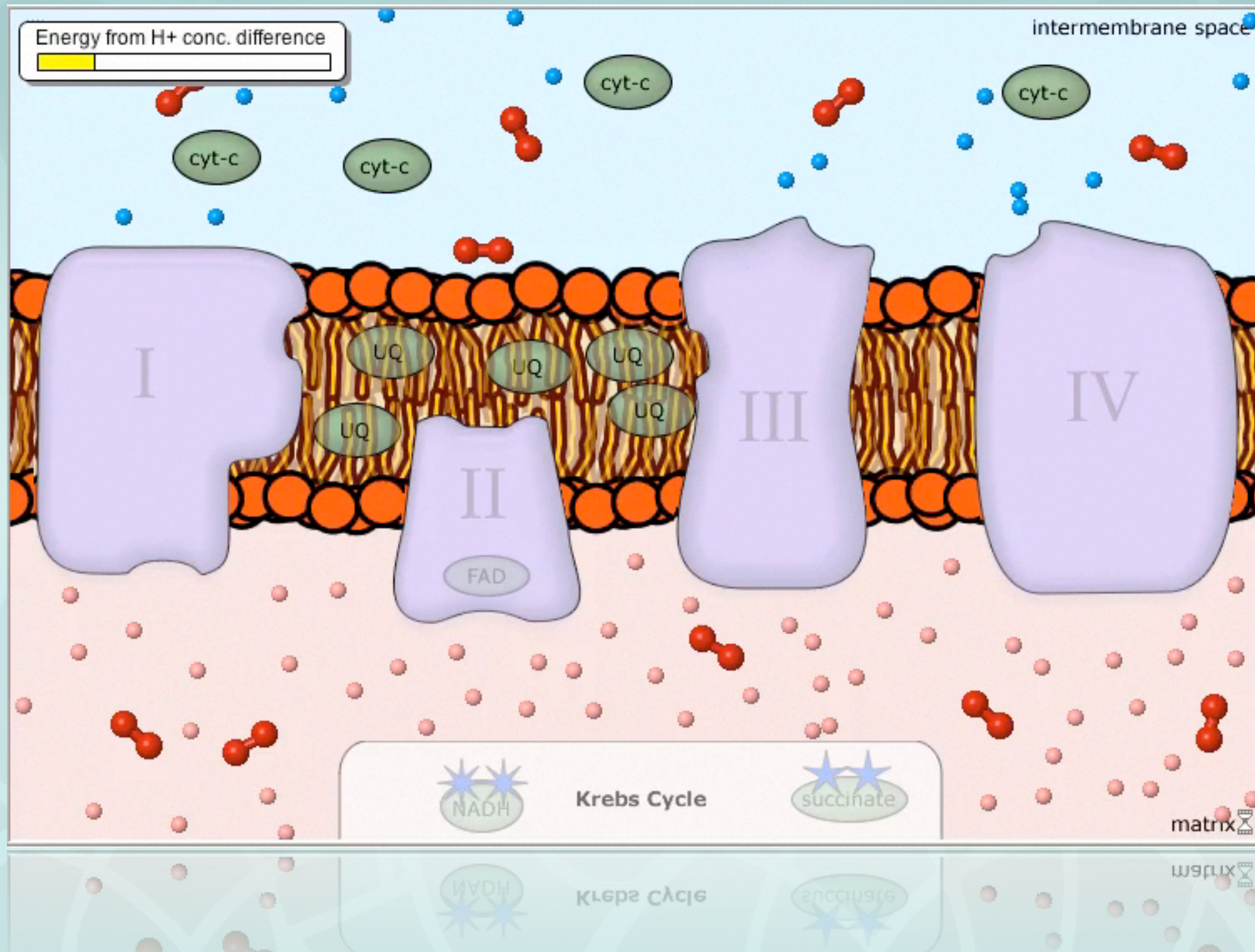
▶ Run

⏏ Stop

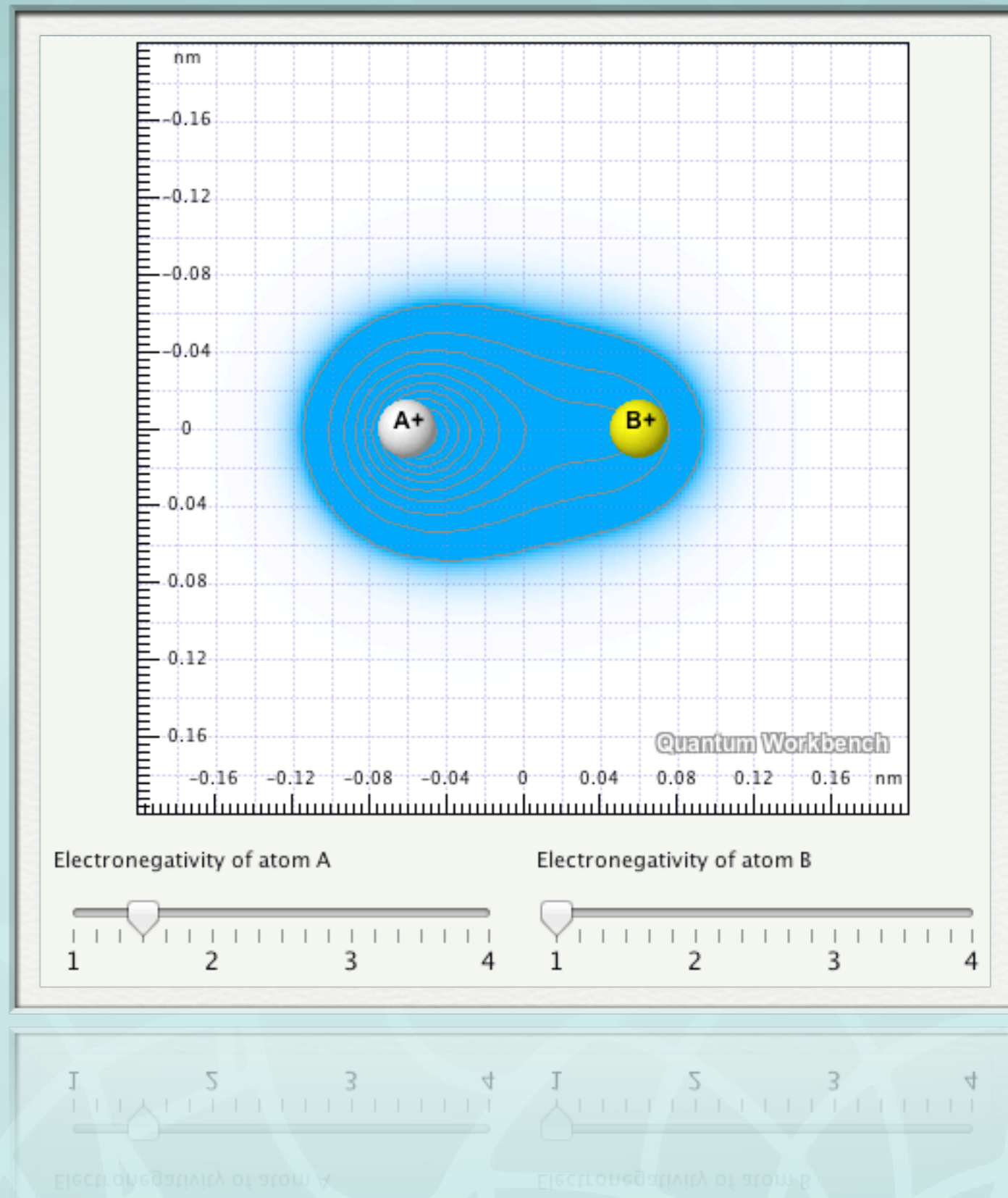
⏮ Reset

press run to see the mixture "settle"

Modeling Macro-level Systems the electron transport chain



Quantum Chemistry - Polar Bonds



Inquiry Is Key

- Going deeper can simplify science
 - Most scientific phenomena can be explained by fundamental ideas of the atomic nature of matter, conservation of energy, Nature's tendency toward equilibrium.
 - Science through this lens is more connected - less individual facts to "memorize".
- Conceptual understanding is the goal.
- Utilize interactive models, to allow inquiry at the atomic level.
- Teachers are essential for inquiry approach to work.

What is “Evolution Readiness?”

What’s included:

Natural selection as an explanatory model for adaptation

Changes take place *slowly and over a long time*

Individual organisms do not evolve

What’s not included:

Genetic and molecular basis of inheritance

Dramatic changes over long stretches of time

Fossil evidence for evolution

The Virtual Greenhouse

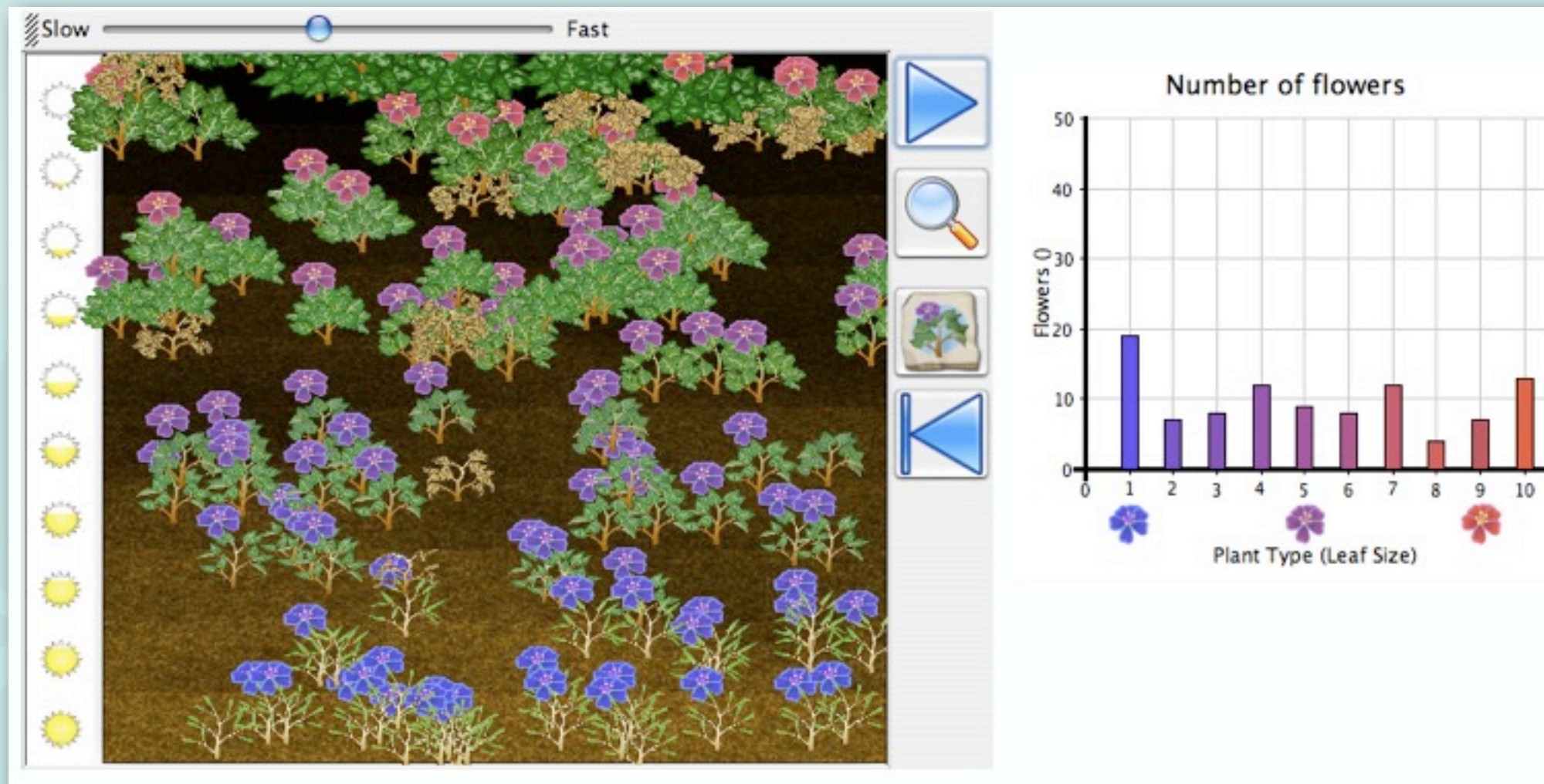
- Adaptation
 - Three kinds of plants, five flower boxes with differing amounts of light
 - Kids experiment to discover which plants live in which flower box



Plants with variation

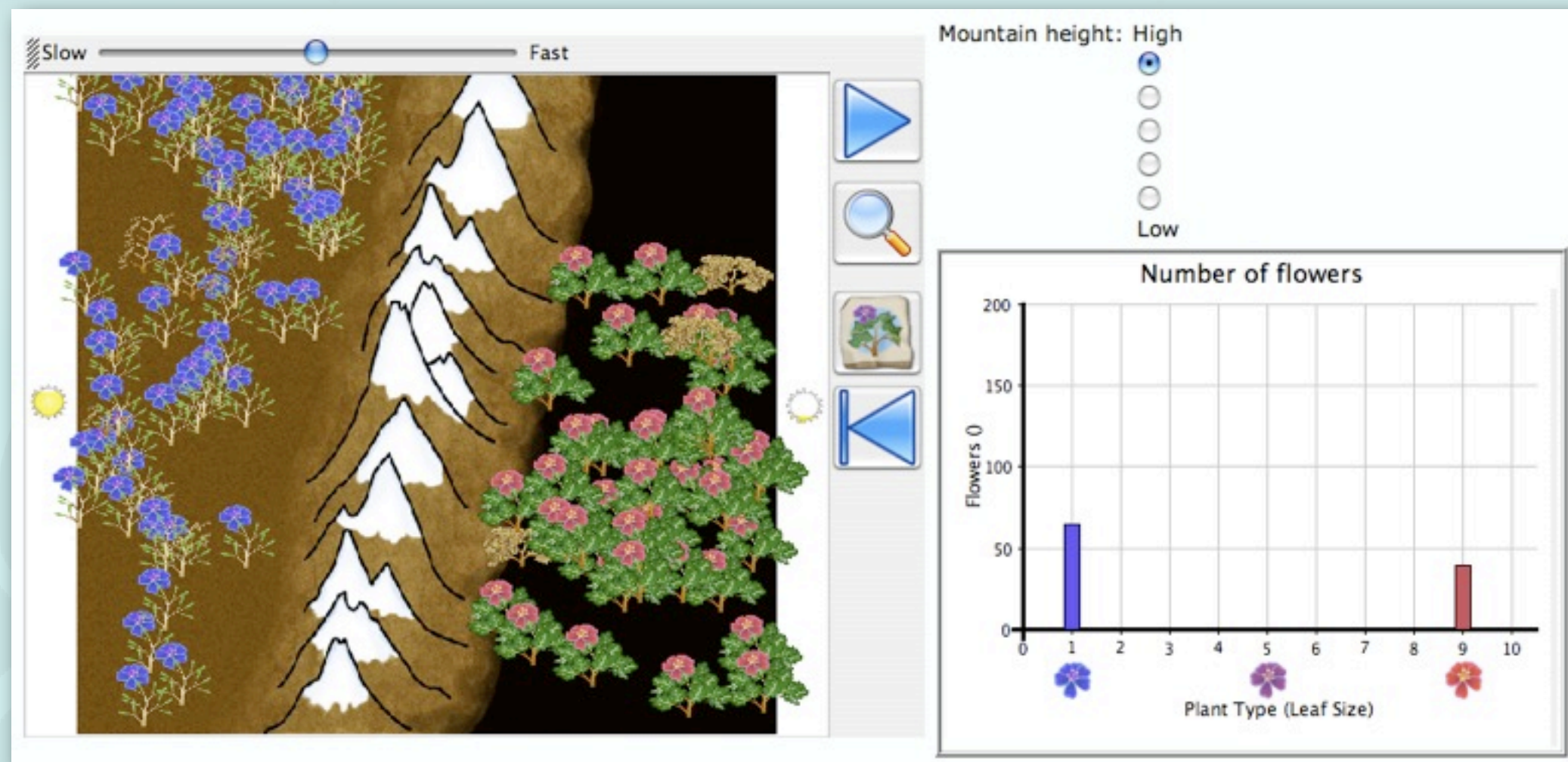
- **Variation:**

- Some offspring differ from parents: over many generations small variations build up.
- A single variety of plant evolves into nine others
- The different varieties are adapted to different regions of the field; eventually they can grow everywhere



Evolution

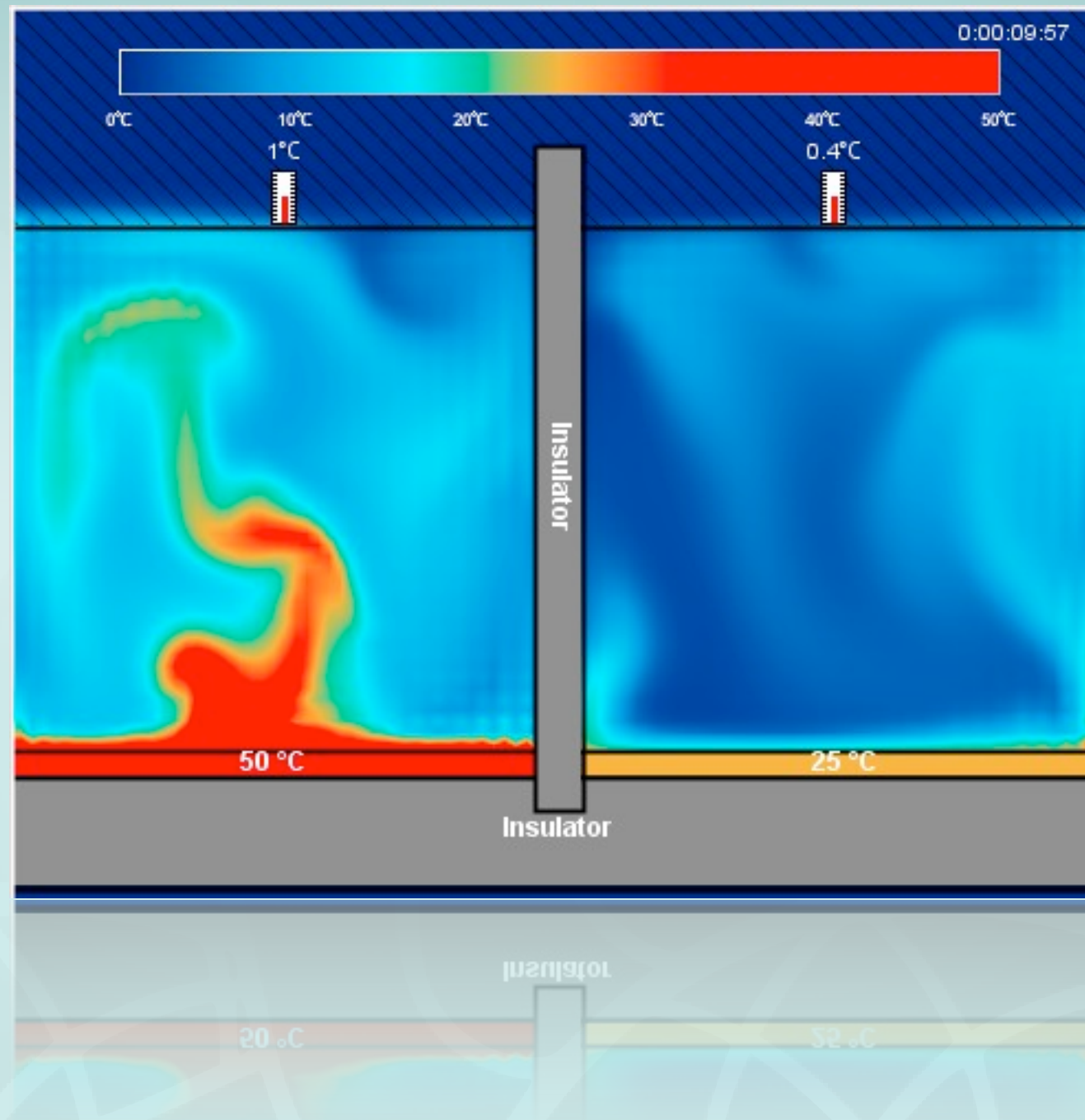
- What happens when the environment changes?
 - Students control the growth of mountains
 - the environment changes on each side of the mountain range
 - If the environment changes too abruptly the plants all die



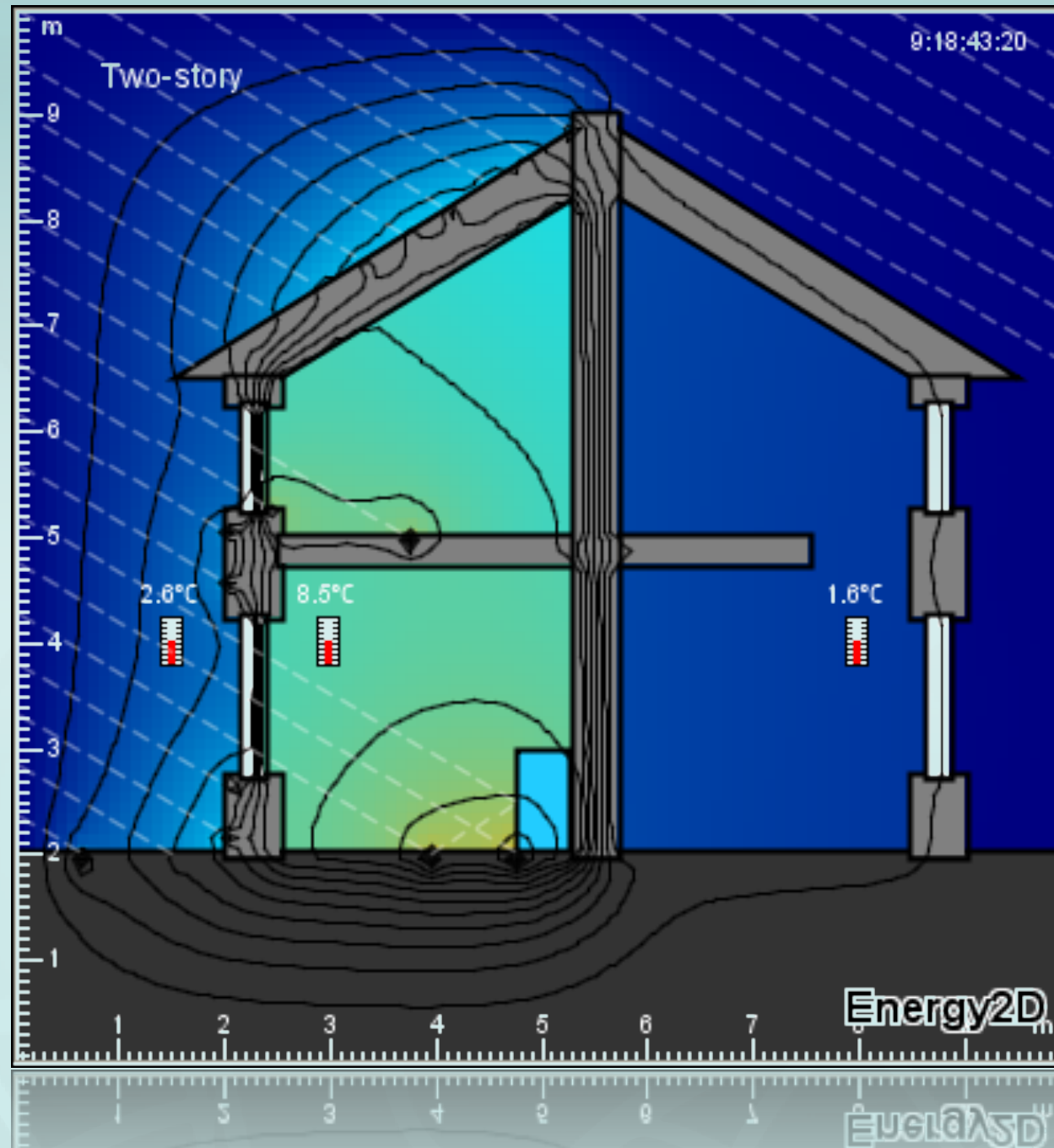
Engineering Energy Efficiency

- Use models to study heat flow.
- Design models in 3D software
- Build physical model
- Use probes to test predictions and refine design.

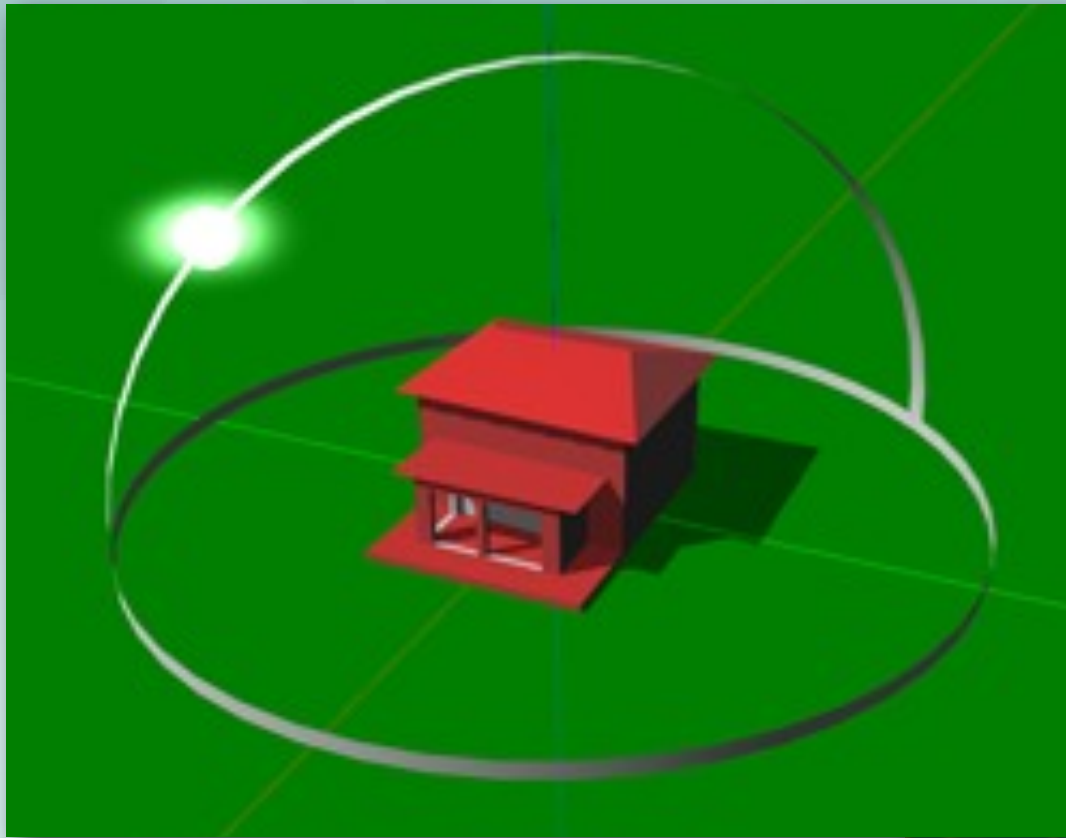
Convection



Design Principles



3D Design



Build Prototype & Use Sensors

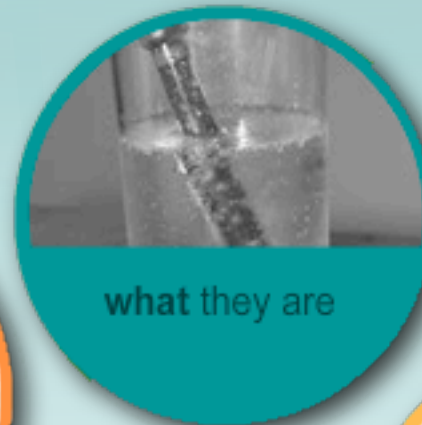


Probes

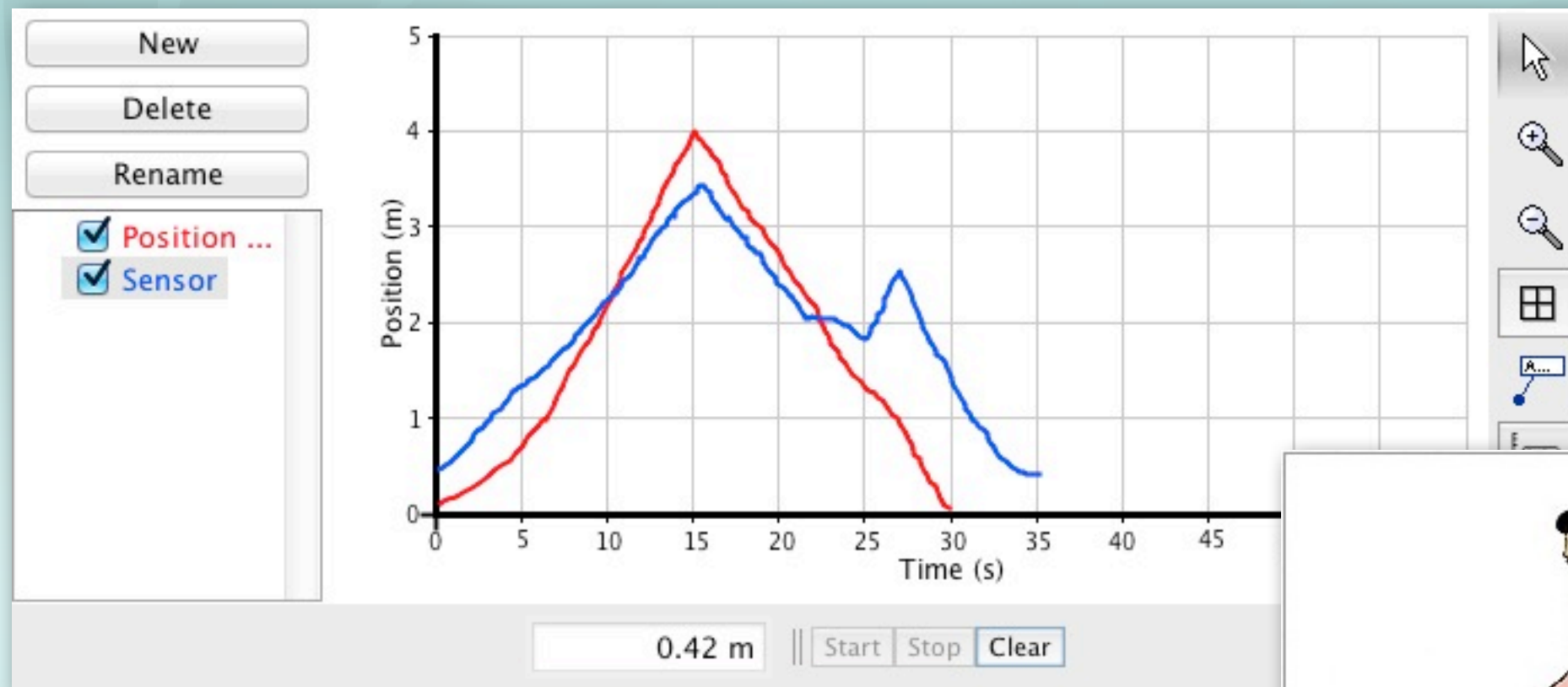
Probes are Valuable Tools

- **displays immediately** data that one normally can't see with another device (sonar ranger displays velocity and acceleration)
- **collects data faster** than normal devices (sometimes over thousands of times per second)
- records and displays **data collected over long periods** of time (some even up to a year)
- displays **simultaneously on the same graph** combines the collection from **multiple probes**
- uses the results of two or more different probes to provide a **derived display** (for example, electrical power being displayed from data collected from a voltage and current probe)

Probesite

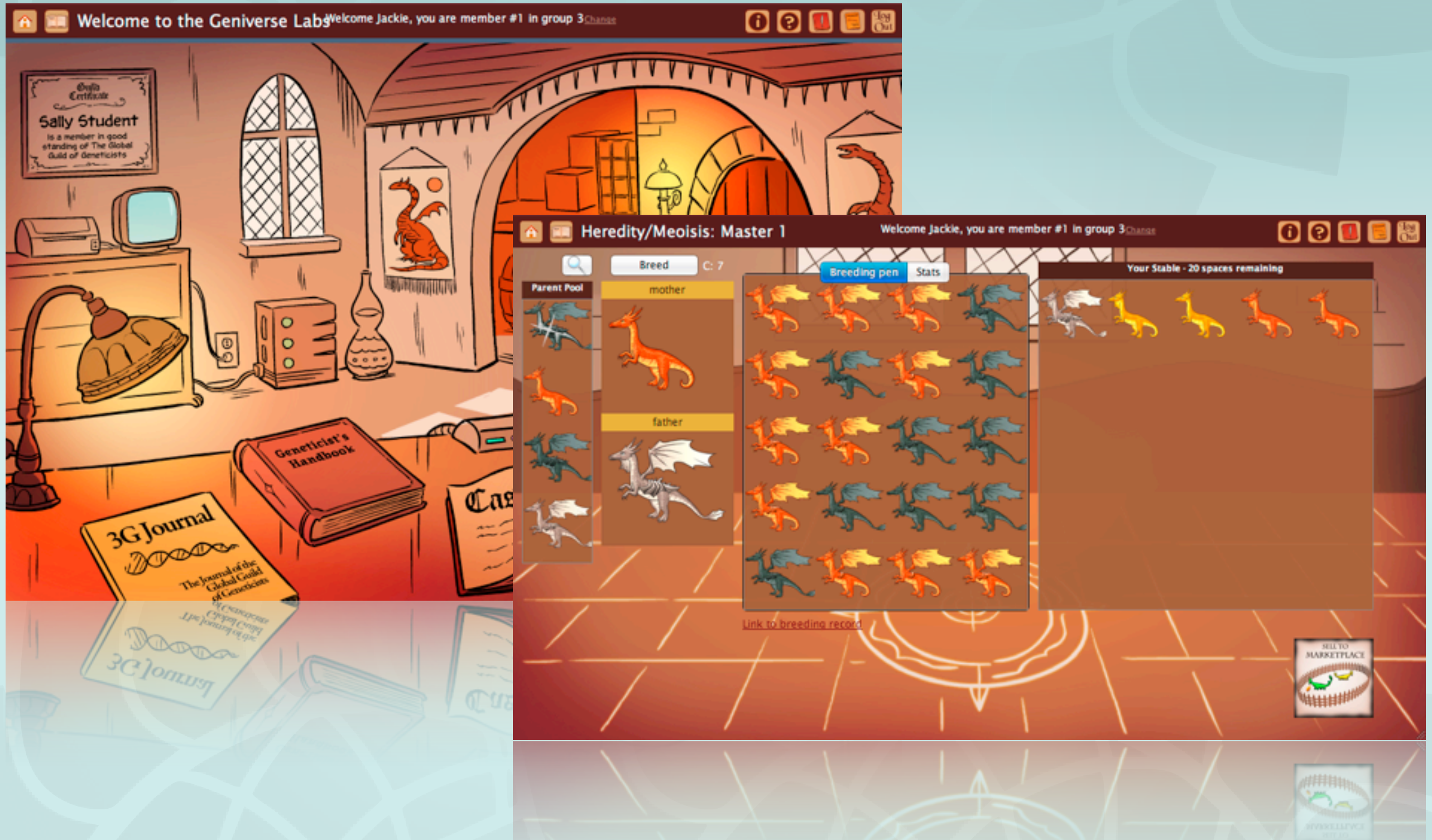


Predict and Measure



Games

Geniverse



The screenshot displays the Geniverse Lab interface, which is divided into two main sections: a virtual lab environment and a breeding simulation window.

Virtual Lab Environment:

- Header:** "Welcome to the Geniverse Lab" and "Welcome Jackie, you are member #1 in group 3".
- Lab Setup:** Includes a desk with a computer monitor, a lamp, a "Geneticist's Handbook", and a "3G Journal". A framed certificate on the wall reads: "Sally Student is a member in good standing of The Global Guild of Geneticists".
- Background:** A stylized illustration of a building with a large arched doorway and a window.

Breeding Simulation Window:

- Header:** "Heredity/Meiosis: Master 1" and "Welcome Jackie, you are member #1 in group 3".
- Buttons:** "Breed", "C: 7", "Breeding pen", and "Stats".
- Parent Pool:** A vertical list of dragon icons representing the parent pool.
- Mother/Father Selection:** Two columns showing the selected mother (orange dragon) and father (white dragon) for breeding.
- Breeding Pen:** A grid of 20 dragon icons representing the offspring in the breeding pen.
- Stable:** A section titled "Your Stable - 20 spaces remaining" showing a row of dragon icons.
- Link to breeding record:** A text link at the bottom of the breeding pen grid.
- Marketplace:** A button labeled "SELL TO MARKETPLACE" with a small icon of a dragon in a marketplace.

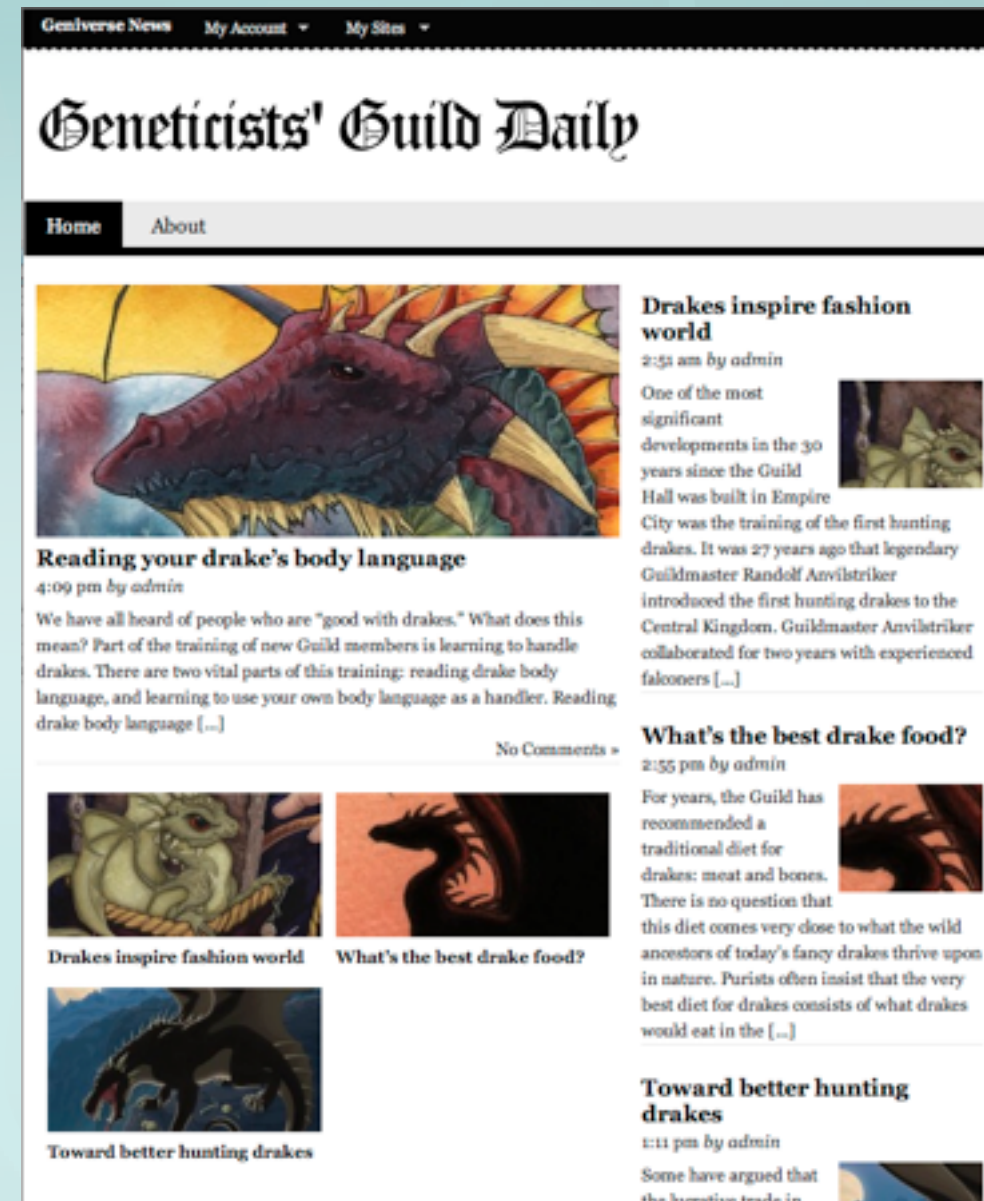
Science vs. Gameplay

- Accurate science
- Maintain fun elements of play
- Motivation
- Assessment

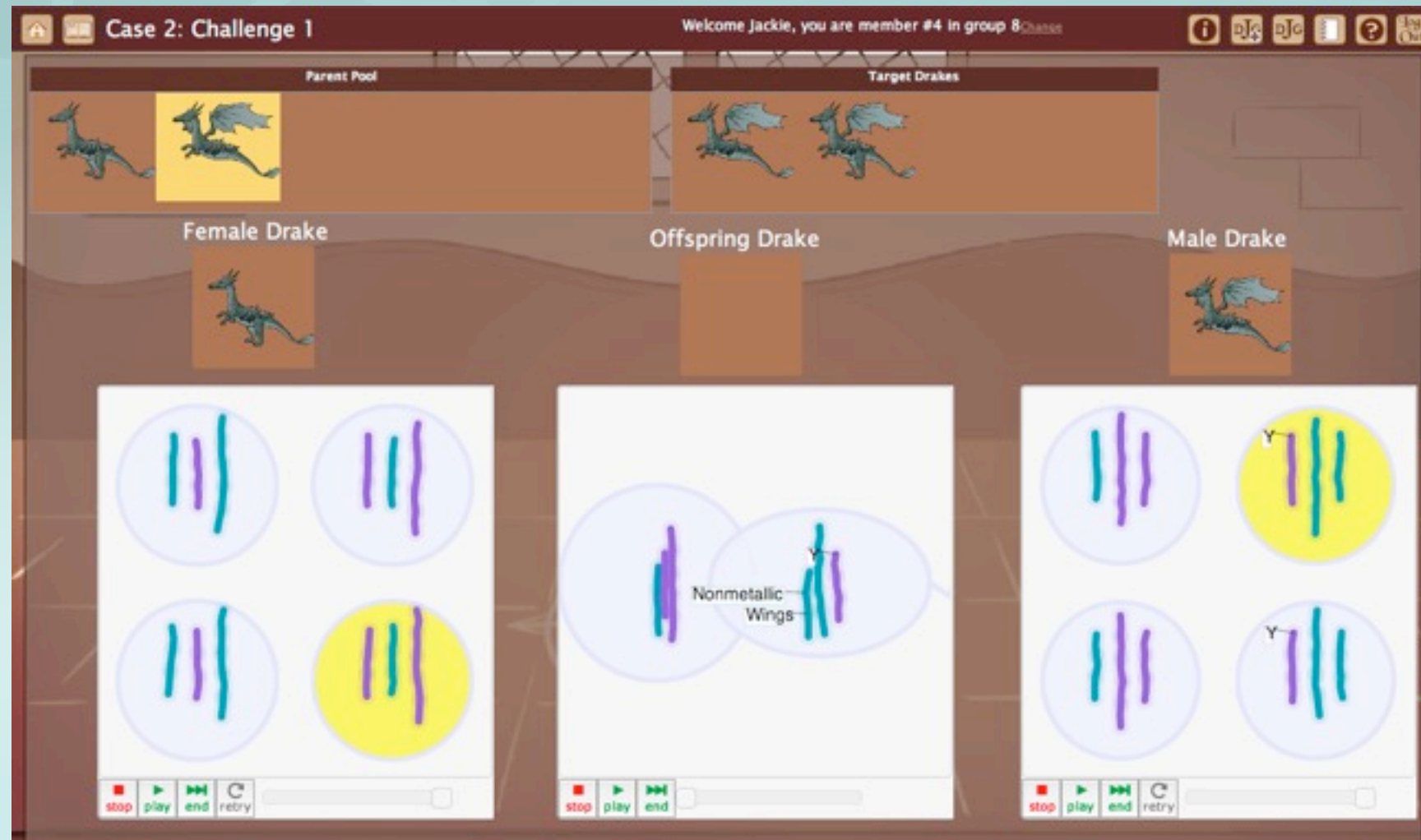


Student As Scientist

- Scientific process
- Focus on argumentation and reasoning
- Class, group, and student blogs



Geniverse



Let's play

Finding Materials

- Concord Consortium Activity Finder
<http://www.concord.org/activities>
- Molecular Workbench Application and Database
<http://mw.concord.org>
- Various Project portals
<http://www.concord.org/projects>

- Science of Atoms and Molecules (SAM/RI-ITEST)

- High Adventure Science

- Geniverse

- Evolution Readiness

- Electron Technologies

- Innovative Technology in Science Inquiry (ITSI-SU)

- Engineering Energy Efficiency




Science of Atoms and Molecules

Current Integration Possibilities

- launch as "preview" mode (no registration)
 - common experience for discussion
 - can create your own questions to be asked within whatever system you use
 - if blended mode, could even hand out paper with questions
 - If running an MW authored activity, many have a "print" option which could print to PDF for online submission (or paper)
- register class for portal containing particular activity
 - will collect data electronically
 - teachers can generate customized reports

Previewing Models and Using a Portal

Welcome Anonymous User. [LOGIN](#) | [SIGN UP](#)



High-Adventure Science

[HOME](#) | [ABOUT](#) | [PREVIEW INVESTIGATIONS](#)

You have been logged out.

PROJECT SIGN IN

Username

Password

☐ Stay logged in

[Forgot Password](#)

First Time Here?

Sign up for access as:

[Student »](#)

[Teacher »](#)

Just want to Try the Units?

[View our unit Previews »](#)

IMPORTANT! Before running our software and activities, please view our [Technical Notes and Requirements section](#)



Contact Info

Dan Damelin

dan@concord.org

<http://www.concord.org>

subscribe to our newsletter